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[CA/CA]; 229 Kingham Road, Acton, Ontario L7G 4S6 (CA). **FISCHER, Jonathon** [CA/CA]; 210 Chartwell Road, Oakville, Ontario L6J 3Z8 (CA). **GUNTHER, Hans** [CA/CA]; 371 Delrex Boulevard, Georgetown, Ontario L7G 4E9 (CA).

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(74) Agent: **BERESKIN & PARR**; 40 King Street West, 40th Floor, Toronto, Ontario M5H 3Y2 (CA).

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(71) Applicant (*for all designated States except US*): **MOLD-MASTERS LIMITED** [CA/CA]; 233 Armstrong Avenue, Georgetown, Ontario L7G 4X5 (CA).

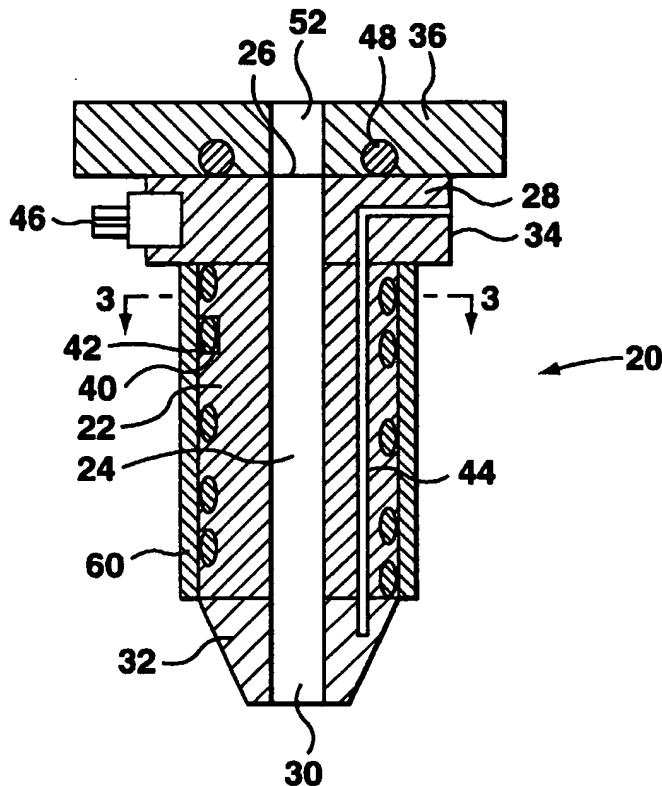
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(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **BABIN, Denis**

[Continued on next page]

(54) Title: THERMALLY BALANCED HOT RUNNER NOZZLE



(57) Abstract: The present invention is directed to a nozzle for an injection molding machine. The nozzle includes a body defining a melt channel. A heater is connected to the nozzle body. A heat distributor is also connected to the nozzle body. The heat distributor is formed of a conductive material for distributing heat from the heater along the nozzle body.

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**Title: THERMALLY BALANCED HOT RUNNER NOZZLE****FIELD OF THE INVENTION**

This invention relates to molding machines and in particular to nozzles for molding machines.

**5    BACKGROUND OF THE INVENTION**

Molding machines include hot runner nozzles that define a melt channel for passing molten material to a desired location such as a mold cavity. It is important that the molten material be kept at a desired temperature to ensure that it flows and cures properly. Typically, hot runner  
10    nozzles are heated with a resistance heater that is wound about the outer surface of the nozzle body. A thermocouple is disposed within the nozzle body to sense the body temperature and the resistance heater is operated by a control system to maintain the body at a desired temperature.

A problem with such conventional nozzles is that the  
15    temperature within the nozzle varies over the length of the nozzle body. Usually, the ends of the nozzle tend to be much cooler than the middle portion of the nozzle due to heat losses occurring at the ends. As a result, it is difficult to maintain the melt within the melt channel at a constant desired temperature. This is problematic in particular for molten materials that are  
20    sensitive to minor changes in temperature. If the temperature is increased too much then the melt will burn in the middle portion of the nozzle, and if the temperature is decreased to avoid burning then the melt might have flow problems or other problems that will effect its ability to cure properly within the mold cavities.

25    There is a need for an apparatus to heat the melt channel within a nozzle body to a desired temperature that remains relatively constant over the length of the nozzle.

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**SUMMARY OF THE INVENTION**

In one aspect the invention provides a nozzle for a molding machine comprising:

- a nozzle body defining a melt channel;
- 5 a heater connected to said nozzle body along at least a portion of the length of said nozzle body; and
- at least one heat distributor connected to said nozzle body, said heat distributor being formed of a conductive material for distributing heat from said heater along said nozzle body.

10 **BRIEF DESCRIPTION OF THE DRAWINGS**

For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made by way of example to the accompanying drawings. The drawings show preferred embodiments of the present invention, in which:

- 15 Fig. 1 is a graph of nozzle temperature over the length of a nozzle;

Fig. 2 is a sectional view of a nozzle in accordance with the present invention;

- 20 Fig. 3 is a transverse sectional view of the nozzle of Fig. 2 taken along lines 3-3;

Fig. 4 is a sectional view of a second embodiment of nozzle in accordance with the present invention;

Fig. 5 is a transverse sectional view of the nozzle of Fig. 4 taken along lines 5-5;

- 25 Fig. 6 is a sectional view of a third embodiment of nozzle in accordance with the present invention;

Fig. 7 is a transverse sectional view of the nozzle of Fig. 6 taken along lines 7-7;

- 30 Fig. 8 is a transverse sectional view of the nozzle of Fig. 6 taken along lines 8-8;

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Fig. 9 is a transverse sectional view of the nozzle of Fig. 6 taken along lines 9-9.

Fig. 10 is a sectional view of a fourth embodiment of nozzle in accordance with the present invention;

5            Fig. 11 is a transverse sectional view of the nozzle of Fig. 10 taken along lines 11-11;

Fig. 12 is a sectional view of a fifth embodiment of nozzle in accordance with the present invention;

10           Fig. 13 is a transverse sectional view of the nozzle of Fig. 12 taken along lines 13-13;

Fig. 14 is a transverse sectional view of a sixth embodiment of nozzle in accordance with the present invention; and

Fig. 15 is a schematic view of an injection molding machine with nozzles in accordance with the present invention.

## 15    **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

Referring to Fig. 1, a temperature profile over the length of a conventional hot runner nozzle is shown at 10. The profile 10 shows lower temperatures 12 at the ends of the nozzle and higher temperatures 14 at the middle of the nozzle. A desired temperature profile for a nozzle in  
20    accordance with the present invention is shown at 16. The desired temperature is relatively constant over the length of the nozzle.

Referring to Figs. 2 and 3, a nozzle in accordance with a first embodiment of the present invention is shown generally at 20. The nozzle 20 includes a body 22 that defines a melt channel 24. Nozzle body is  
25    typically formed of steel or other suitable materials known to persons skilled in the art. The nozzle has an inlet 26 defined at a first end 28 and an outlet 30 defined at a second end 32. Second end 32 typically is defined as a frustoconical tip. A collar 34 is defined at the first end for mounting the nozzle 20 to a manifold 36.

30           Nozzle 20 includes a continuous channel 40 defined in its outer surface for receiving a resistance heater, such as for example a coil

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heater 42. Examples of suitable resistance heaters are disclosed in US Patents 4557685, 5266023 and 5704113 which are all hereby incorporated by reference. Resistance coil heater 42 is wound over the length of the nozzle and is preferably disposed fully within channel 40 such that the outer  
5 surface of the heater 42 lies generally flush with the outer surface of the nozzle body 22. Heater 42 may be secured to channel 40 with a press friction fit or through metalurgical bonding such as brazing or other securing means known to persons skilled in the art. A thermocouple 44 is disposed in nozzle body 22 for sensing the temperature of the nozzle body 22 adjacent  
10 to melt channel 24. Heater 42 is coupled to a power supply 46 for powering the heater 42. The thermocouple 44 and heater 42 are connected to a control system (not shown) that monitors the temperature of nozzle body 22 and operates heater 42 as required to maintain desired temperature profile 16. A manifold heater 48 is disposed in manifold 36 to similarly heat molten  
15 material passing through a manifold melt channel 52.

A heat distributor 60 is disposed on nozzle body 22 over a desired portion of its length. Heat distributor 60 is formed of a conductive material such as copper or a copper alloy that will conduct heat produced by heater 42 along the length of heat distributor 60. Heat distributor 60 may be  
20 preformed as a hollow sleeve that is closely fitted to nozzle body by means of a friction fit or by means of braising, welding, or other attachment methods known to those skilled in the art. Alternatively, heat distributor 60 may be applied to the outer surface of nozzle body 22 by spraying or dipping the conductive material directly onto nozzle body 22. Preferably, heat  
25 distributor 60 is in direct physical contact with heater 42 and with nozzle body 22 in order that an optimum heat transfer and distribution can be achieved. As a result, heat distributor 60 acts to distribute heat sufficiently over its length to produce a relatively constant temperature profile 16 over the corresponding length of nozzle 20.

30 Referring to Figs. 4 and 5, a second embodiment of nozzle 20 in accordance with the present invention is shown. For convenience,

- 5 -

corresponding elements as described above are assigned corresponding reference numbers.

In the second embodiment of nozzle 20, nozzle body 22 has heat distributor 60 disposed upon its outer surface. A hollow heater sleeve 70 is then disposed on the outer surface of heat distributor 60. Heater sleeve 70 defines continuous channel 40 for receiving heater 42. Heater 42 is connected to power supply 46 for powering the heater 42. A second heat distributor 60' is disposed externally of heater sleeve 70 to further aid in distributing heat along the desired length of nozzle body 22. A thermal insulator 72 such as a ceramic or other suitable insulation material known to those skilled in the art may in some instances be disposed externally to heat distributor 60'.

Referring to Figs. 6 - 9, a third embodiment of nozzle in accordance with the present invention is shown. Again, for convenience, corresponding elements to the embodiments described above are given corresponding reference numbers.

The third embodiment of nozzle 20 includes nozzle body 22 which defines in its outer surface continuous channel 40 for receiving heater 42. Nozzle body 22 is configured to include a reduced diameter portion 80 at an intermediate region between the first and second ends 26, 32 of nozzle 20. Reduced diameter portion 80 provides a region of heat loss to reduce the likelihood of high temperature 14 in the intermediate region of nozzle 20. Reduced diameter portion 80 provides a smaller mass to transfer less heat from the heater 42 to the molten material flowing through the melt channel.

Heater 42 is also disposed at second end 32 of nozzle body 22 for maintaining temperature of the melt within nozzle body 22 prior to exiting from outlet 30.

Heat distributor 60 is disposed on nozzle body 22 for distributing heat along the length of nozzle body 22 to achieve relatively constant temperature profile 16. Heat distributor 60 includes apertures 82 overlying reduced diameter portions 80 of nozzle body 22 to allow heat loss

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over the intermediate region of nozzle body 22. Heat distributor 60 also is disposed at second end 32 of nozzle body 22 to distribute heat over the length of second end 32. The location of heat distributor 60 on second end 32 is of particular utility when second end 32 is formed as by frustoconical tip where it is difficult to dispose heater 42 adjacent to outlet 30.

Referring to Figs. 10 - 11, a fourth embodiment of nozzle in accordance with the present invention is shown. Again, for convenience, corresponding elements to the embodiments described above are given corresponding reference numbers.

10 The fourth embodiment of nozzle 20 includes nozzle body 22 with melt channel 24. Heater 42 is a film heater such as is disclosed in the following patents which are hereby incorporated by reference: EP963829, EP312029, WO0023245, and WO0117317. Surrounding film heater 42 is an electrical insulator 90 that protects the film heater 42. Heat distributor 60  
15 is then disposed over electrical insulator 90.

Referring to Figs. 12 - 13, a fifth embodiment of nozzle in accordance with the present invention is shown. For convenience, corresponding elements to the embodiments described above are given corresponding references numbers.

20 The fifth embodiment of nozzle 20 includes nozzle body 22 that defines melt channel 24. Nozzle heater 42 is in the form of a resistance wire that is disposed in a dielectric material disposed around nozzle body 22. Nozzle heater 42 includes a first dielectric layer 92 that is disposed over nozzle body 22. A resistive wire 94 is then wrapped around nozzle body 22  
25 over first dielectric layer 92. A second dielectric layer 96 is then disposed over resistive wire 94 and first dielectric layer 92. This type of heater 42 is described in more detail in PCT application PCT/CA01/00274 which is hereby incorporated by reference. Heat distributor 60 is disposed over second dielectric layer 96 in order to distribute heat from resistance wire  
30 heater 42 over the length of heat distributor 60.

Referring to Fig. 14, a sixth embodiment of nozzle 20 in accordance with the present invention is shown. Again, for convenience,



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corresponding elements to the embodiments described above are given corresponding reference numbers.

The sixth embodiment of nozzle 20 is similar to the first embodiment described above. Nozzle 20 includes nozzle body 22 which  
5 defines in its outer surface continuous channel 40 for receiving heater 42. Heat distributor 60 is disposed on nozzle body 22 over a desired portion of its length. Heat distributor 60 includes a longitudinal slit 98 to accommodate thermocouple 44 so that the thermocouple 44 may be disposed against nozzle body 22.

10 Referring to Fig. 15, a schematic view of an injection molding machine 100 is shown with nozzles 20 in accordance with the present invention. For convenience, corresponding elements to the embodiments described above are given corresponding reference numbers.

The injection molding machine 100 includes an inlet nozzle  
15 102 that is connected to manifold 36. Manifold 36 includes melt channel 104 for distributing melt from inlet nozzle 102 to injection nozzles 20. Injection nozzles 20 include collar 34 for mounting injection nozzles 20 to manifold 36. Injection nozzles 20 are connected to mold cavity 106 in known manner for introducing the molten material into mold cavity 106. Injection  
20 nozzle 20 include nozzle body 22 that is heated with heater 42. Heat distributor 60 is disposed over nozzle body 22 for distributing heat from heater 42 over the length of heat distributor 60. Heat distributor 60 thus acts to distribute heat sufficiently over its length to produce a relatively constant temperature profile 16 over the corresponding length of nozzle 20.

25 It is to be understood that what has been described is a preferred embodiment to the invention. If the invention nonetheless is susceptible to certain changes and alternative embodiments fully comprehended by the spirit of the invention as described above, and the scope of the claims set out below.

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**WE CLAIM:**

1. A nozzle for a molding machine comprising:  
a nozzle body defining a melt channel;  
a heater connected to said nozzle body along at least a portion  
5 of the length of said nozzle body; and  
at least one heat distributor connected to said nozzle body,  
said heat distributor being formed of a conductive material for distributing  
heat from said heater along said nozzle body.
2. A nozzle as claimed in claim 1 further comprising a continuous  
10 channel defined in said nozzle body for receiving said heater.
3. A nozzle as claimed in 2 wherein said heater is disposed in  
said continuous channel such that said heater is generally flush with an  
outer surface of said nozzle body.
4. A nozzle as claimed in claim 2 wherein said heater is pressed  
15 in said continuous channel.
5. A nozzle as claimed in claim 2 wherein said heater is brazed in  
said continuous channel.
6. A nozzle as claimed in claim 1 wherein said heat distributor is  
a preformed hollow sleeve.
- 20 7. A nozzle as claimed in claim 1 where said heat distributor is  
fluidly deposited on said nozzle body.
8. A nozzle as claimed in claim 1 further comprising a thermal  
insulator disposed over at least a portion of said heat distributor.

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9. A nozzle as claimed in claim 1 wherein said heat distributor is brazed to said nozzle body.
10. A nozzle as claimed in claim 1 wherein said heater is a film heater.
- 5 11. A nozzle as claimed in claim 1 wherein said heater is a resistance wire heater disposed in a dielectric material.
12. A nozzle as claimed in claim 1 wherein said heater is metallurgically bonded to said nozzle body.
- 10 13. A nozzle as claimed in claim 6 wherein said sleeve defines a longitudinal slit for positioning a thermocouple proximate to said nozzle body.
14. An injection molding machine comprising:  
an inlet nozzle for introducing a molten material to the molding machine:
- 15 a manifold in communication with said inlet nozzle for receiving and distributing said molten material;  
a plurality of injection nozzles in communication with said manifold for receiving said molten material, said injection nozzles being in communication with corresponding mold cavities, each said injection nozzle
- 20 having a heater connected to a nozzle body along at least a portion of the length of the nozzle body and at least one heat distributor connected to the nozzle body for distributing heat from said heater along said nozzle body.
15. A nozzle as claimed in claim 14 further comprising a continuous channel defined in said nozzle body for receiving said heater.

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16. A nozzle as claimed in 15 wherein said heater is disposed in said continuous channel such that said heater is generally flush with an outer surface of said nozzle body.

17. A nozzle as claimed in claim 15 wherein said heater is  
5 pressed in said continuous channel.

18. A nozzle as claimed in claim 15 wherein said heater is brazed in said continuous channel.

19. A nozzle as claimed in claim 14 wherein said heat distributor is a preformed hollow sleeve.

10 20. A nozzle as claimed in claim 14 where said heat distributor is fluidly deposited on said nozzle body.

21. A nozzle as claimed in claim 14 further comprising a thermal insulator disposed over at least a portion of said heat distributor.

22. A nozzle as claimed in claim 14 wherein said heat distributor is  
15 brazed to said nozzle body.

23. A nozzle as claimed in claim 14 wherein said heater is a film heater.

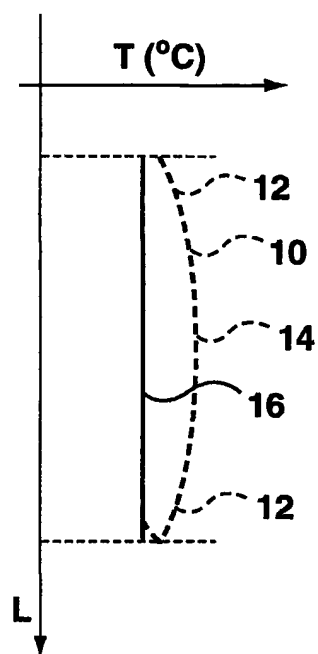
24. A nozzle as claimed in claim 14 wherein said heater is a resistance wire heater disposed in a dielectric material.

20 25. A nozzle as claimed in claim 14 wherein said heater is metallurgically bonded to said nozzle body.

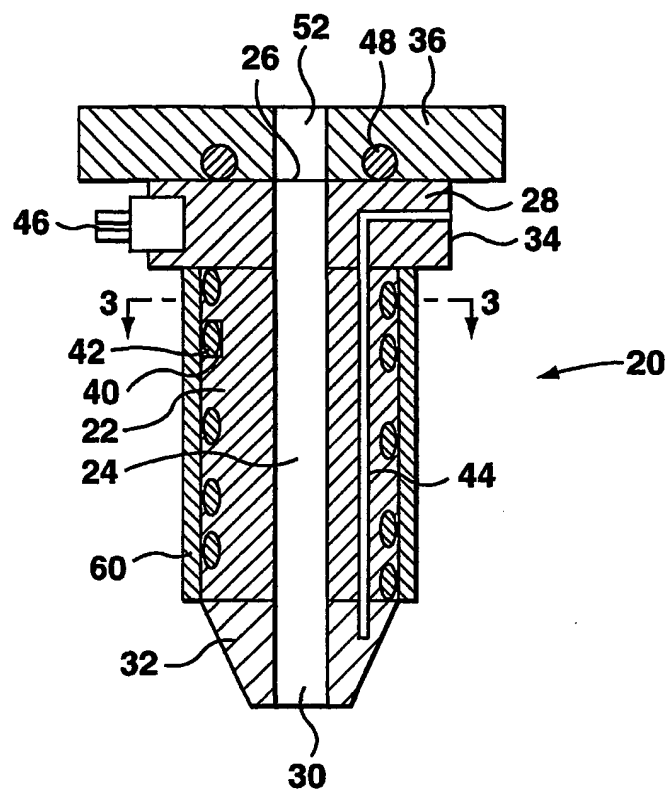
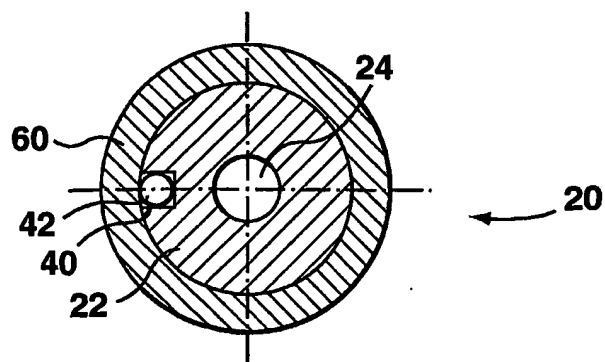
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26. A nozzle as claimed in claim 19 wherein said sleeve defines a longitudinal slit for positioning a thermocouple proximate to said nozzle body.

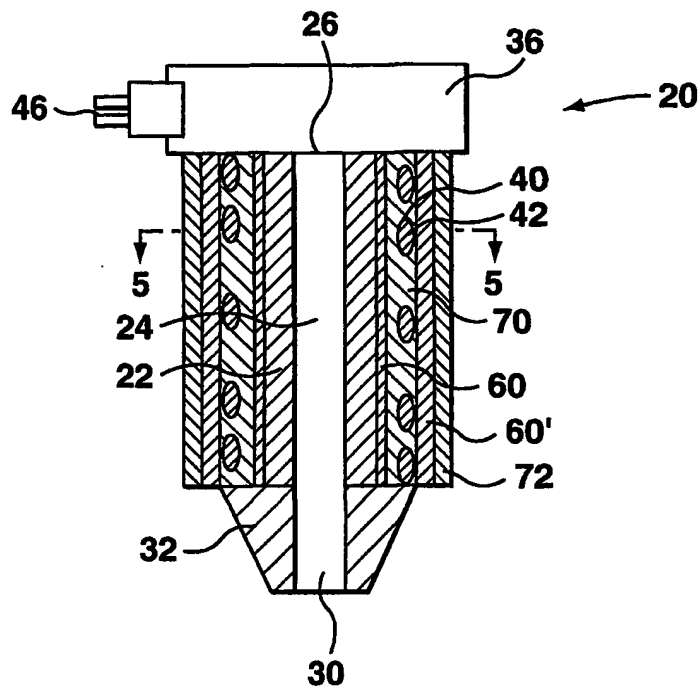
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**FIG. 1**

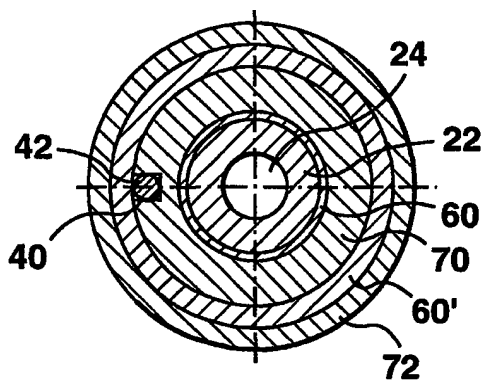
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**FIG. 2****FIG. 3**

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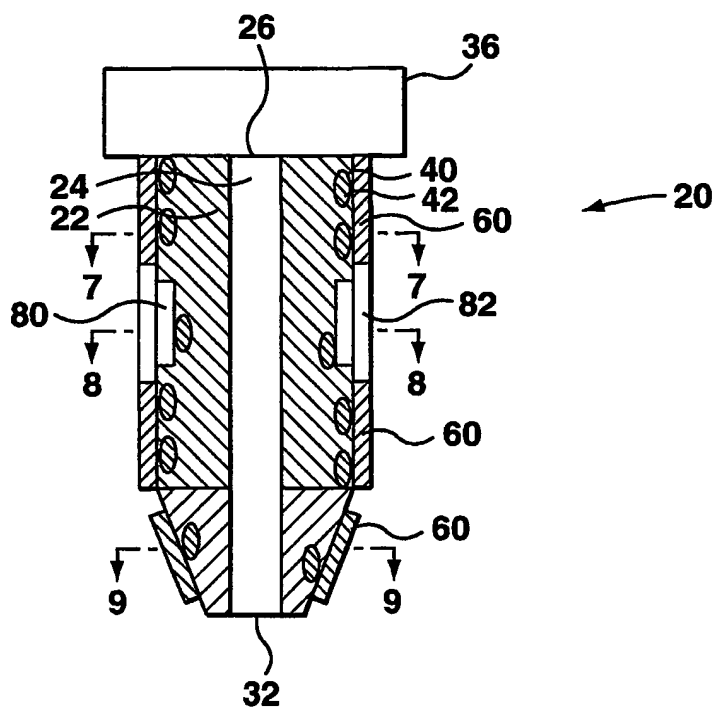


**FIG. 4**

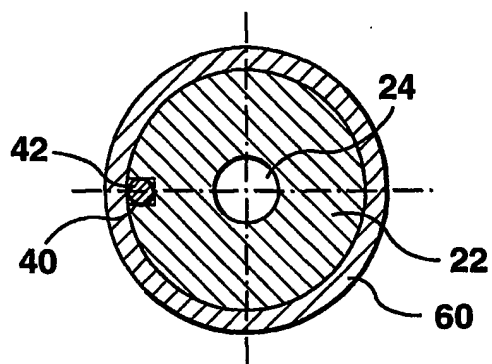


**FIG. 5**

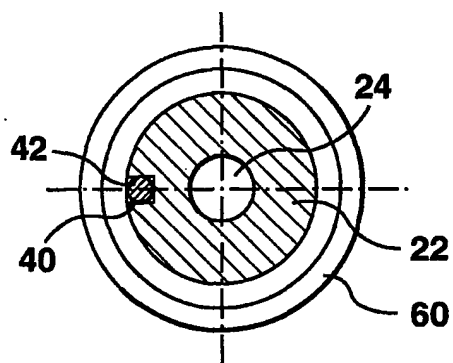




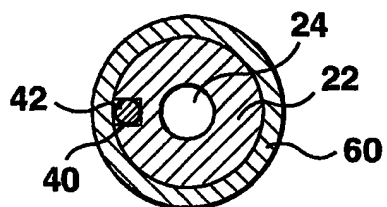
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**FIG. 7**

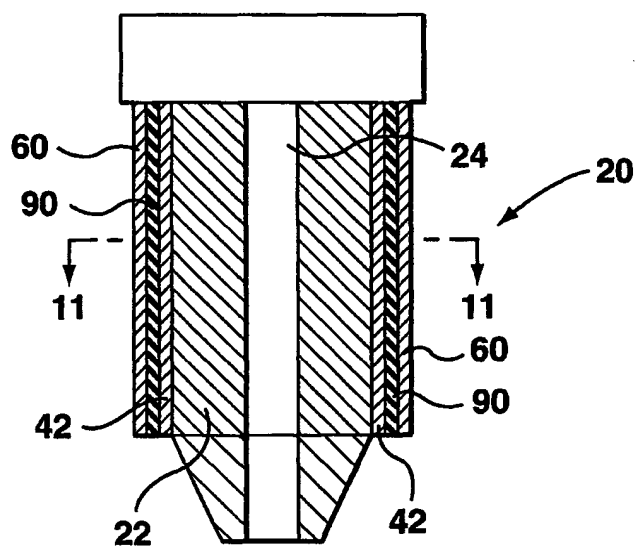
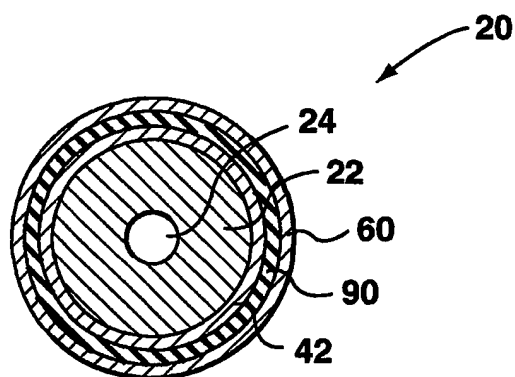


**FIG. 8**

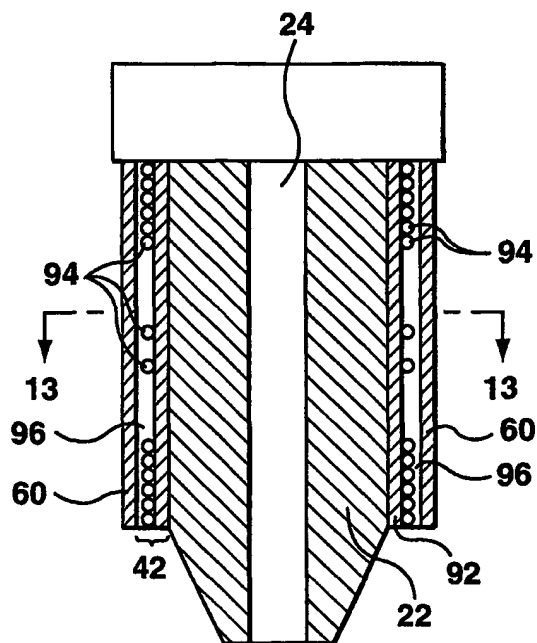


**FIG. 9**

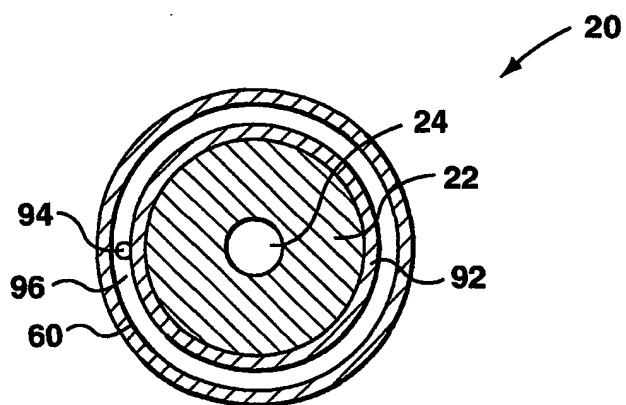
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**FIG. 10****FIG. 11**

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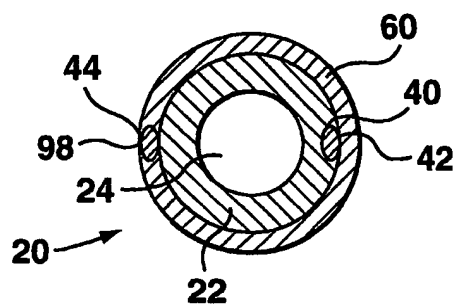
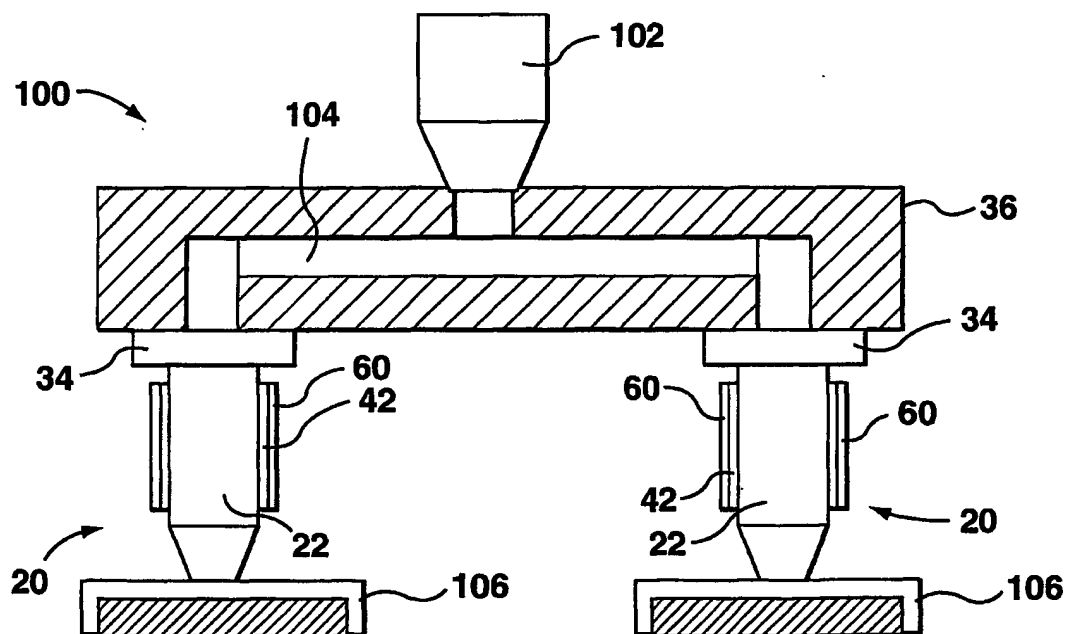


**FIG. 12**



**FIG. 13**

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**FIG. 14****FIG. 15**

## INTERNATIONAL SEARCH REPORT

Internat Application No  
PCT/CA 01/00910

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 B29C45/27

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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European Patent Office, P.B. 5816 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

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Internat. Application No.  
PCT/CA 01/00910

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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